

Thermoelectric Materials with the Skutterudite Structure: New Results

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New experimental findings on semiconductors with the relatively complex 32 atom unit cell skutterudite crystal structure show that these materials possess attractive transport properties and have a good potential for achieving ZT values larger than for state-of-the-art thermoelectric materials. Both n-type and p-type conductivity samples have been obtained, using several preparation techniques. Associated with a low hole effective mass, very high carrier mobilities, low electrical resistivities and moderate Seebeck coefficients are obtained in p-type skutterudites. For a comparable doping level, the carrier mobilities of n-type samples were found to be about an order of magnitude lower than values of p-type samples. However, the much larger electron effective masses and Seebeck coefficients make n-type skutterudites even more promising candidates. The thermal conductivities of the binary skutterudite compounds at high temperatures are comparable to the values obtained for Si-Ge alloys, but are too large to be useful for thermoelectric applications at lower temperatures. However, in addition to literature results, a large number of isostructural compounds, solid solutions and related phases have been discovered. These skutterudite compositions offer many possibilities for substantially reducing the lattice thermal conductivity and for optimizing the electrical properties to a specific temperature range of thermoelectric applications. An overview of recent results is provided and current approaches to experimentally achieving high ZT in skutterudite materials are discussed in this paper.